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AN/SSQ-41A/53 SONODROP: FLOCELERATOR/ DECELERATOR WIND TUNNEL TEST RESULTS

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The Naval Air Development Center has conducted an analysis of aerodynamic decelerators for A-size sonobuoys. To obtain pertinent aerodynamic information, particularly drag data on various decelerators and flocelerators needed for mathematical simulation and future design, the Glenn L. Martin Institute of Technology Low Speed Wind Tunnel at the University of Maryland was utilized. This report summarizes the testing effort involved and presents the data for application to the refinement of current A-size

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sonobuoys. The data will also be applicable to the proposed ERAPS and MAPS presently under study as part of AIRTASK A370370A/202B/F00-121-710.

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NAVAIRDEVCEN Report No. NADC-72165-VT-A (Revision A), "AN/SSQ-41A/53 Sonodrop: Flocelerator/Decelerator Wind Tunnel Test Results," 18 September 1972 (Unclassified)

Cover	- Deleted old AIRTASK and Work Unit number; inserted new AIRTASK and Work Unit number. Changed distribution statement to Distribution Unlimited.
Report Documentation Page	- Deleted old AIRTASK and Work Unit number; inserted new AIRTASK and Work Unit number. Changed distribution statement to Distribution Unlimited.
Page 3	- Deleted "average" before T/I in first paragraph. - Reworded second sentence in last paragraph.
Pages 14 thru 18	- Figure 8: deleted average T/I column ($\overline{T/I}$) and added drag area column ($C_D S$) to reflect change in data reduction method. Data reduction method changed to using actual T/I effect vice average T/I effect. Consequently, corrected drag column (Do), drag area column ($C_D S$), and average drag area column ($\overline{C_D S}$) were affected.
Pages 20, 21	- Figure 10: values under average drag area column ($\overline{C_D S}$) and average drag coefficient column ($\overline{C_D}$) were corrected to reflect change made in drag reduction methodology.

INTRODUCTION

On 10 and 11 May, 1972, the Glenn L. Martin Institute of Technology Low Speed Wind Tunnel at the University of Maryland was utilized to provide information for several programs now underway at the Naval Air Development Center. Full scale models of A-size sonobuoys and deployable decelerators -- parachutes and floceleraters -- were tested as part of Airtask A5335330/2025/2P04000001. Information derived from these wind tunnel tests will also be utilized to provide preliminary data for the proposed Expendable Reliable Acoustic Path Sonobuoy (ERAPS) and Multi-element Array Passive Sonobuoy (MAPS), under study through Airtask A370370A/202B/F00-121-710.

Testing of the models involved simulated sonobuoy deployments at various speeds, high speed photographic coverage to establish flocelerator inflation times, and compilation of drag data to determine appropriate drag areas (C_DS) of the proposed systems. Background information as to the development of these sonobuoy systems can be found in references (a), (b), and (c).

This report summarizes the effort involved in the wind tunnel tests of the various sonobuoy/decelerator systems. Preliminary remarks regarding the models tested are limited to discussion of type, and illustrative figures are provided for clarification. The tunnel test set-up, data compiled, and data reduction are also described. Resultant data are summarized in tabular form.

WIND TUNNEL TEST SET-UP/MODEL DESCRIPTION

The Glenn L. Martin Institute of Technology Low Speed Wind Tunnel at the University of Maryland is of the single return, closed throat rectangular type with a test section 7.75 feet high by 11.04 feet wide and is capable of speeds up to 335 feet per second. Located beneath the test section is a six component yoke type balance system composed of electrically driven automatic beam balances. Data from the balance system is simultaneously indicated at the tunnel operator's position on a central control console and on an illuminated number panel for plotting. In addition, all indicated data are automatically recorded in print and IBM punch card form. A detailed description of equipment available, data reduction capabilities, and other pertinent wind tunnel information can be found in reference (d).

The tunnel test set-up for the flocelerator and parachute models is depicted in figure 1. An A-size sonobuoy body, equipped with an NAVAIRDEVCEN (Naval Air Development Center) designed aft sonobuoy module, was mounted on the tunnel centerline at zero angle of attack by means of a strut connected to the tunnel balance. A fairing, surrounding the strut and independent of it, was mounted directly to the test section floor. The floceraters and parachute models were tested trailing the sonobuoy body after simulated deployment at various tunnel speeds.

Simulated deployment was accomplished by packaging the flocelerator/parachute model in a drogue-bag, which in turn was housed inside the aft sonobuoy module. The drogue-bag was secured in the aft module by a steel through pin. Actual deployment was achieved by releasing this pin after the desired wind tunnel speed was attained. The drogue, free in the air-stream, pulled the bag out of the module releasing the model. After deployment, the drogue-bag was constrained to the tunnel downstream by a lanyard attached to the tunnel floor. Figure 2 illustrates the deployment sequence.

Two types of trailing flocelerators were tested: the crown flocelerator (figure 3A) and the modified torpedo (figure 3B). The crown flocelerator was tested with both an attached 36 inch square parachute and a 12 x 42 inch cross-type parachute. Two different fabric weights were used in the bag construction, 7 ounce and 5.4 ounce (nominal) polychloroprene coated nylon. The modified torpedo flocelerator also was tested with the two types of parachutes. However, the material used in bag construction was not varied -- all bags consisted of the 7 ounce material with a 5.4 ounce inlet section. In addition, one modified torpedo model was constructed so that the inlet geometry could be varied.

The parachute models consisted of flat circular ribbon and cross types and were tested primarily to obtain drag area (C_DS) and coefficient (C_D). The ribbon parachutes varied in size from 7½ inch diameter to 15 inch diameter (measured across the flats). Two sizes of cross type parachutes were tested, 10 x 30 (b/L = .333) and 12 x 42 inch (b/L = .285). Particulars for the parachutes are outlined in figure 4 for flat circular ribbon type and figure 5 for cross type.

Miscellaneous tests were conducted on the standard A-size sonobuoy rotochute, and on different nose shapes for the sonobuoy. The two different nose shapes tested were the ogive shape and the hemispherical shape. Dimensions are given in figure 6.

For completeness and accuracy of the data, several test runs were necessary for evaluation of the tare and interference (T/I) effects. Since all of the models tested were symmetrical, an image set-up was provided for the T/I test runs, shown in figure 7. The image set-up consisted of a fairing and strut, identical in size and shape to those used in supporting the models in regular test runs, mounted from the ceiling of the tunnel test section. The actual T/I tests involved re-running certain models, using the image set-up, in order to obtain data necessary for corrected results. The data reduction and derived results are outlined in the following section.

DATA REDUCTION/TEST RESULTS

A total of 35 test runs were conducted in the wind tunnel including 8 T/I runs. The reduced data from these runs is shown in figure 8. For

a clear understanding of the results derived, the following paragraph will define the nomenclature used and the procedure employed for data reduction.

The first four columns of figure 8 denote the run and applicable T/I run; a description of the model tested; the test velocity (V) in ft/sec; and the dynamic pressure (q) in lb/ft^2. The next two columns give the uncorrected drag for the test and T/I runs, D and D*. Following this is the T/I effect. which is found by algebraically subtracting D from D*. [T/I negative (D > D*) implies that the majority of interference is due to flow disruption by the fairing. T/I positive (D < D*) implies more flow disruption is caused by the support strut. Although these interference effects could have been separated, the process is long; involving several more runs, and was deemed unnecessary for further refinement of the data.] The corrected drag, D_o, was computed by algebraically subtracting the T/I effect from D. By dividing D_o by q the drag area (C_DS) was found. The average drag area ($\overline{C_DS}$) is given in the last column.

Figure 9 gives the average inflation times for the two floceleratore types in graphical form. The curves were constructed by extrapolating inflation times from the film coverage of the first eight test runs involving floceleratora. Also plotted on figure 9, are the ideal times of inflation calculated from the equation of continuity. As can be seen, inflation times of the torpedo bag are very close to ideal. However, the crown flocelerator experiences an inflation time lag of approximately 0.2 seconds from ideal. A plausible explanation for this lag is the lack of an aerodynamic inlet on crown floceleratora. Inflation does not begin until the attached parachute is inflated, whereas, inflation begins almost immediately upon deployment of the torpedo bag.

The general results of the testing are summarized in figure 10. All similar models were grouped together (e.g. runs #1 and #2 differ only in bag construction material). An average drag area (C_DS), less body effects, was then calculated. The average drag coefficient (C_D) was found by dividing this drag area (C_DS) by a representative area (S). For the floceleratora the nominal cloth areas of the attached parachutes were used for S. Flat circular ribbon parachute representative areas were the cloth areas of circular pieces of material with diameters equivalent to the ribbon parachute "across the flats" measurement (figure 4). Nominal cloth areas were also used for S in the case of cross type parachutes except for runs 18 and 23, where it was noted that the nominal area was considerably less than actual. For the nose shape runs (26, 27 and 28), the frontal area of the A-size body was used for S. Also tabulated in figure 10 are general comments and observations on each significant test run.

DISCUSSION OF TEST RESULTS/CONCLUSIONS

Data obtained from the wind tunnel tests is directly applicable to work being done by the NAVAIRDEVCEN under Airtask A5335330/2025/2P04000001. Information obtained has resulted in the design of a two-stage deceleration system for A-size sonobuoys. In the process, a combination of ram-air-inflated floatation/deceleration system (flocelerator) for A-size sonobuoys was also designed. The wind tunnel data has also been used as computer inputs for preliminary design of a variety of deceleration systems for different size sonobuoys. A listing of the general conclusions about the tunnel test results follows:

1. The body drag coefficients (runs 26, 27, and 28) resulting from these tests, more or less, correspond to classical (book) values for C_D of circular cylinders (reference (e)). In particular, the C_D for the ogive nose proved superior to the others tested. This is a significant result since this shape is volumetrically efficient and is reported to produce stable in-water trajectories. It is therefore considered an excellent candidate shape for any sonobuoy. In addition, these body drag coefficients are applicable to the proposed ERAPS and MAPS systems since, for fineness ratios (body length/body diameter) between 4 and 12, the drag coefficient is relatively constant. The fineness ratios for the sonobuoys under study fall in this range: 7.385 for A-size; 8.727 for ERAPS (B-size store); 6.15 for MAPS (C-size store).

2. Inflation times for the flocelerators are clearly established. The relationship of actual to computed (ideal) times as shown in figure 9 was a significant result of the wind tunnel tests. Extrapolating on this data for proposed ERAPS and MAPS flocelerators should be a straightforward procedure dependent only on final system weights.

3. The crown flocelerator is inherently more advantageous than the torpedo bag flocelerator. It is easier to fabricate, requires significantly less material, and is easier to package in the sonobuoy. This last point was evident from the wind tunnel tests when, during the low speed deployment sequence, the crown flocelerator, being easier to package, was deployed in a much shorter time than the torpedo bag. Also evident from the tests was the fact that the parachute (particularly the square type) when attached to the torpedo bag failed to open during several test runs. This served to enhance the superiority of the crown flocelerator.

4. Insight as to the type of parachute (square or cross) that should be used on a flocelerator was also gained by these tests. As noted in figure 10, the flocelerators with attached cross type parachutes had a tendency to "wrap-up" in the tunnel. This shortcoming is due to the way the models were mounted -- the cross parachute was attached to a rigidly mounted body. In actual flight, any tendency for a cross parachute to "wrap-up" would be translated into a rotation of the body. Therefore, this "turning" observation cannot really be considered a deficiency of the

cross parachute. However, one weakness of the cross parachute/flocelerator arrangement was noted: tying of the suspension lines to the parachute. This area, in a couple of test runs, resulted in some parachute cloth tears. Stitching the suspension lines should correct this problem.

Several problem areas concerning the square parachute were also made apparent. One was the need for a re-enforced flocelerator-parachute attachment necessary to sustain high opening shock forces when deployed at high speed. This re-enforcement should also be radiated out from the bag to the suspension lines. Another area, though only evident when attached to the torpedo bag flocelerator was failure of the parachute to open. However, this problem is only mentioned for completeness of results.

Based on these observations, either parachute could be used on the crown flocelerator. Further testing is required to show any significant difference during actual use.

5. Tests of the ribbon parachutes yielded drag areas consistent with those computed from previous drop tests. However, the tunnel tests indicated a tendency for the bottom ribbon (especially on the larger ribbon parachute)to "curl" and become ineffective at airspeeds greater than 100 feet per second. The most probable reason for this occurrence is that the manufactured suspension lines were improperly sized. This is highly probable, since for ribbon parachutes the suspension line lengths should approximately equal 0.7 of the nominal flat circular diameter (reference (f)). Because the ribbon parachutes tested are small, this dimension is difficult to obtain, analytically -- the nominal diameter could be that diameter as measured across corners, across the flats, or the average of both. Nonetheless, any final ribbon parachute selected should be checked in a wind tunnel to assure proper performance and geometry.

6. The conventional A-size sonobuoy rotochute test was not completed since the model failed during the test. However, a drag area average was derived based on the data obtained. Tare and interference effects were assumed based on T/I effects for the body runs. The result given in figure 10 is the best approximation available from the limited data obtained. The model "failed" due to constant rotation of the blades without adequate bearing support -- causing the blades to separate from centrifugal force when the "washer-type" bearing seized. The failure caused some damage to the tunnel test section (shattering of overhead glass panel, chipping of side shatter-proof glass) and fan ("sand-blast" effect on propeller from the overhead glass particles). Repairs were completed in a few hours and the T/I test runs commenced. However, it is recommended that future wind tunnel testing of rotochutes be conducted with greater caution: substitution of a thrust bearing for the washer type bearing and possibly a metal retaining shroud around the rotochute blades.

REFERENCES

(a) Single Stage Sonobuoy Decelerator Systems, Naval Air Development Center, NADC-AM-TM-1515, March 1971

(b) A-Size Sonobuoy Decelerator Development Component Evaluation Test Program, Naval Air Development Center, NADC-AM-TM-1557, January 1972

(c) Sonobuoy Decelerator Development Program: Summary of Ram-Air Inflation Techniques and Flocelerator Wind Tunnel Testing, Naval Air Development Center, NADC-AM-TM-1662, February 1972

(d) Information for Users of the Glenn L. Martin Institute of Technology Low Speed Wind Tunnel at the University of Maryland, August 1962

(e) Hoerner, S.F., Fluid-Dynamic Drag, published by author, copyright 1958.

(f) Performance of and Design Criteria for Deployable Aerodynamic Decelerators, AD 429 971, December 1963

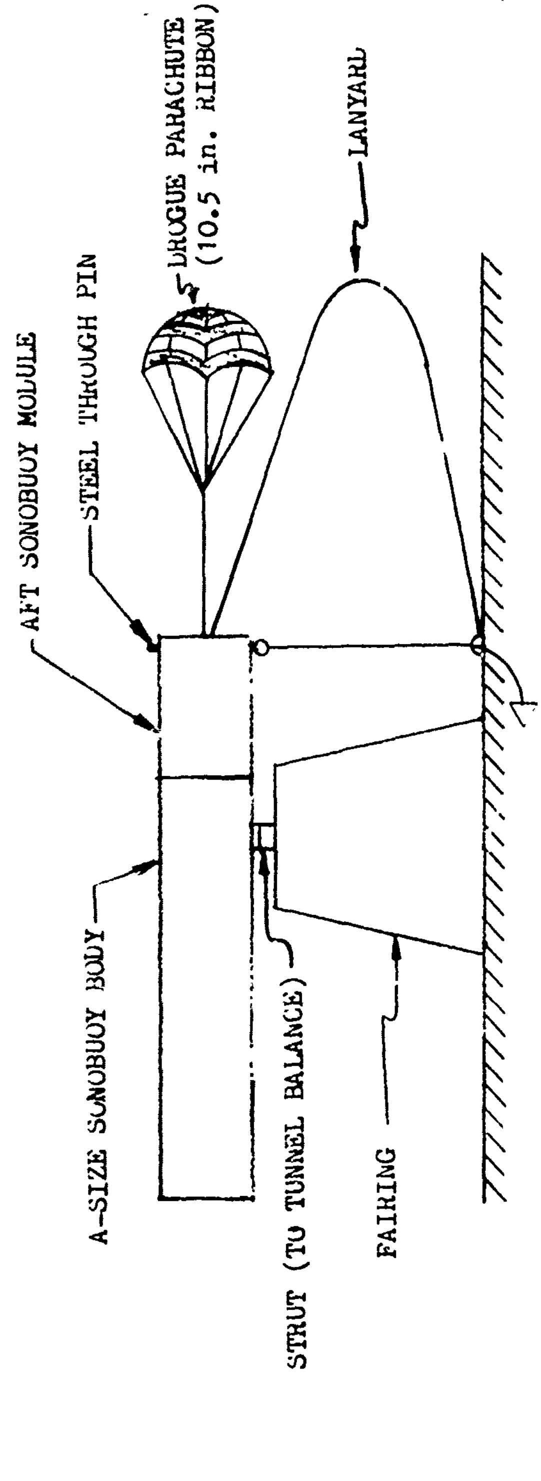

Figure 1: WIND TUNNEL TEST SET UP

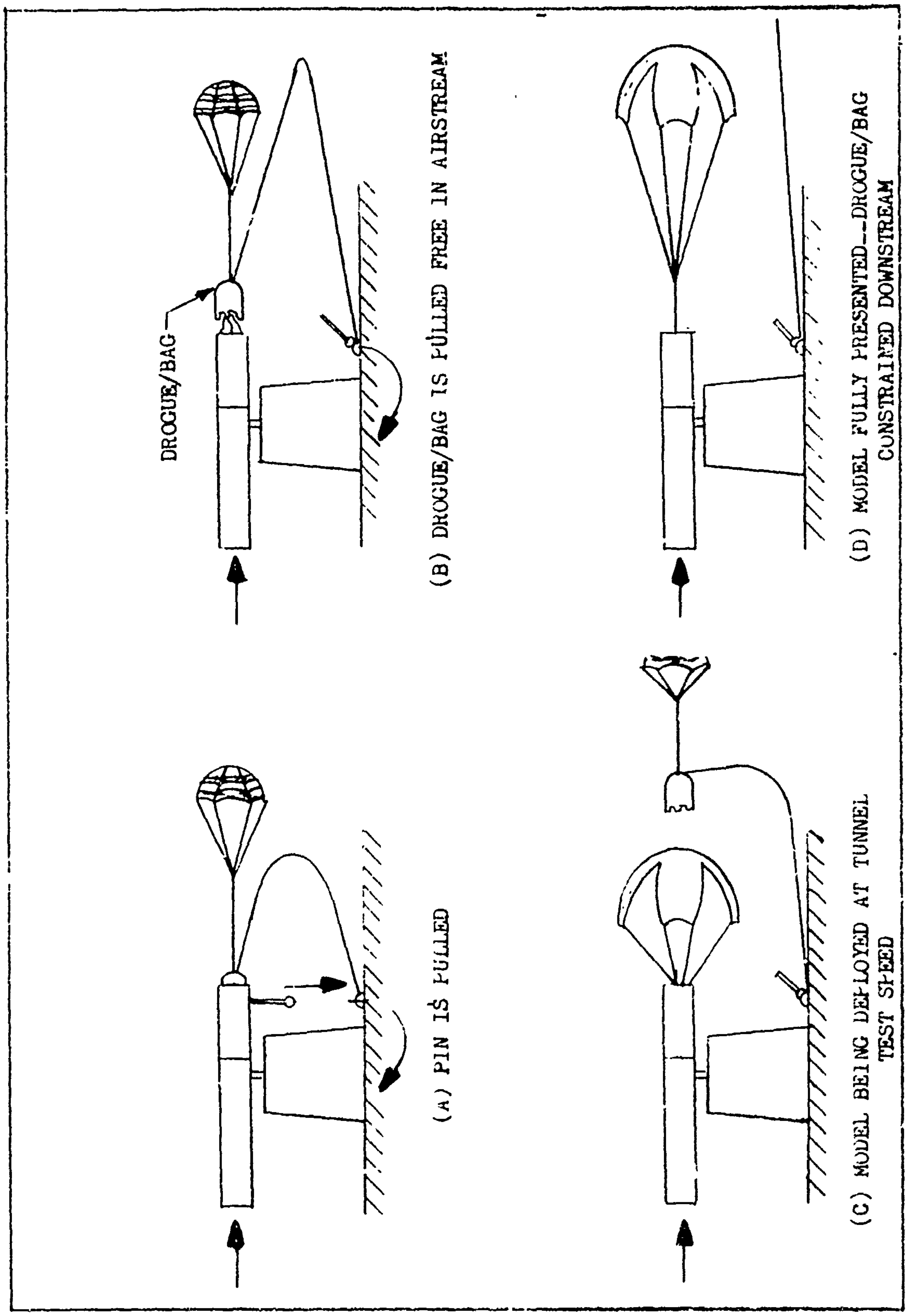

Figure 2: DEPLOYMENT SEQUENCE

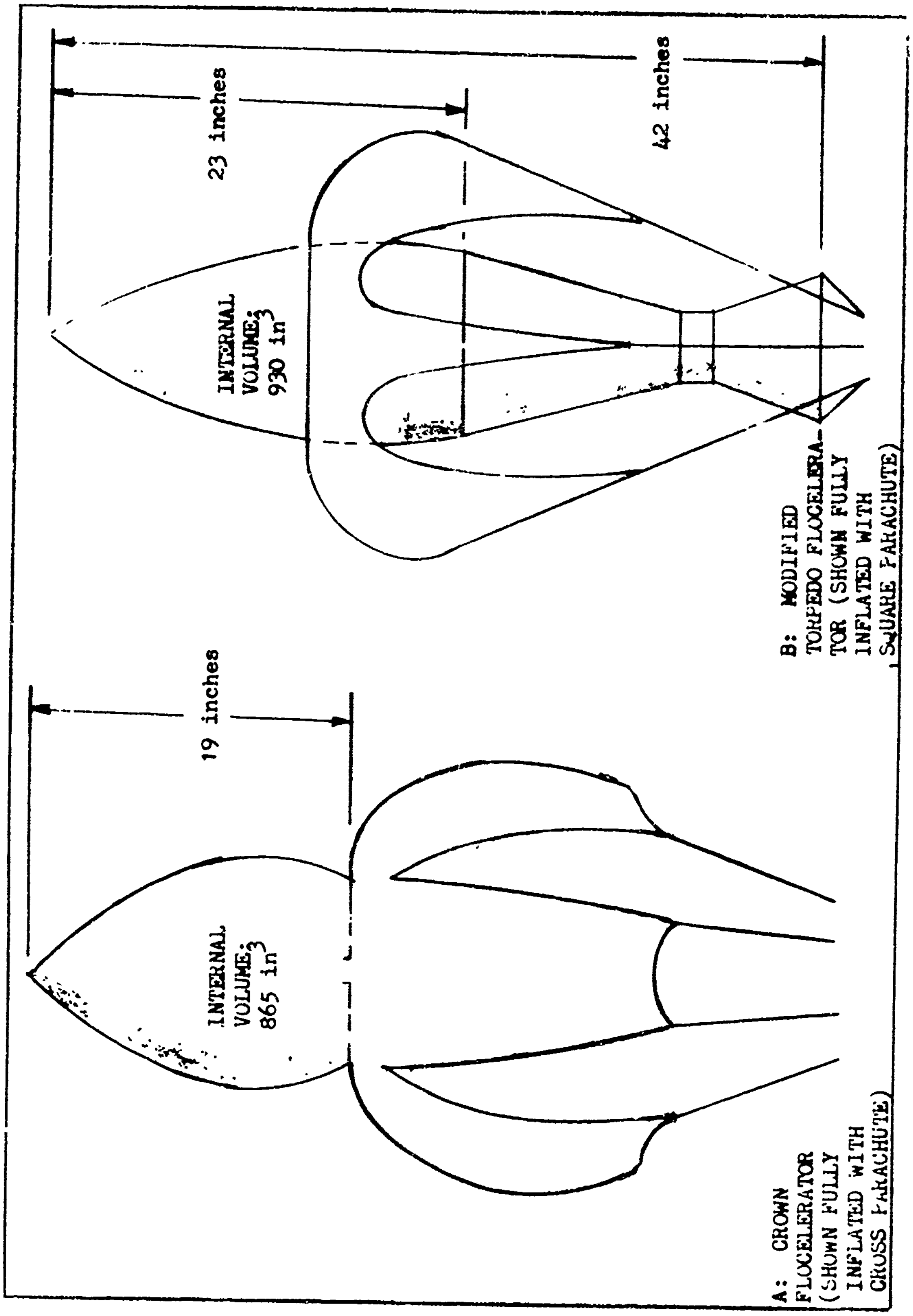

Figure 3: FLOCELERATORS TESTED

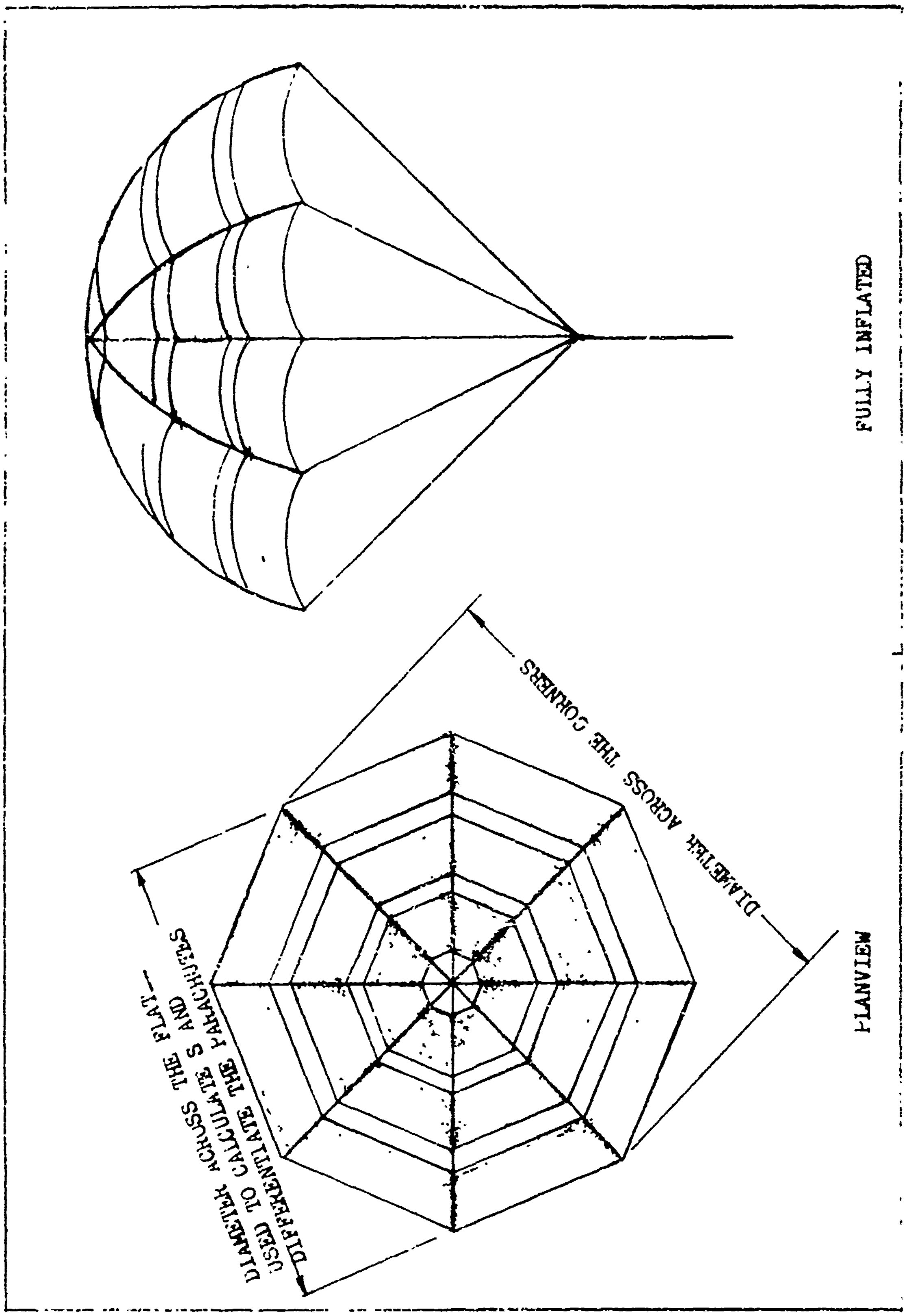

Figure 4: FLAT CIRCULAR RIBBON PARACHUTE

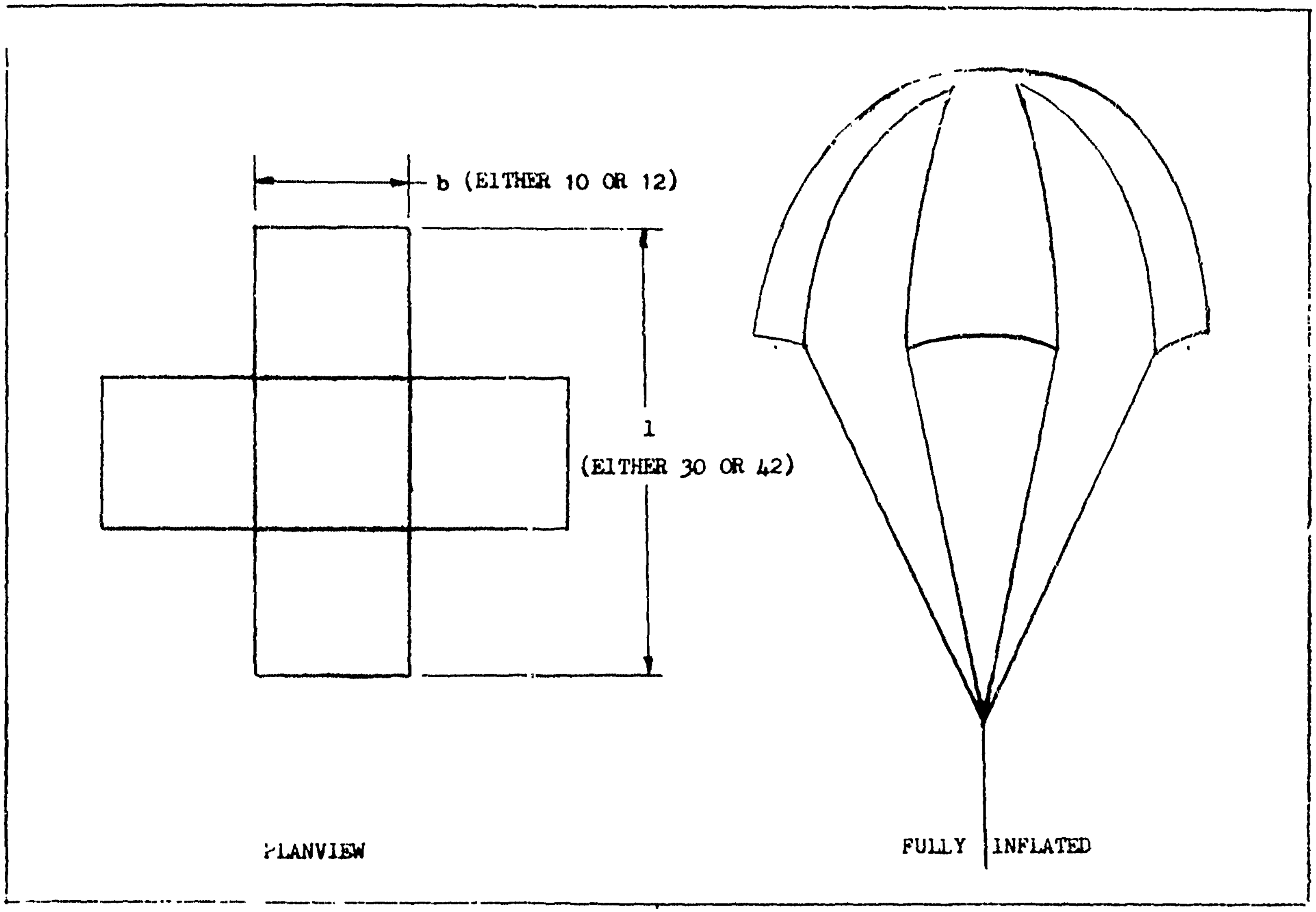

Figure 5: CROSS TYPE PARACHUTE

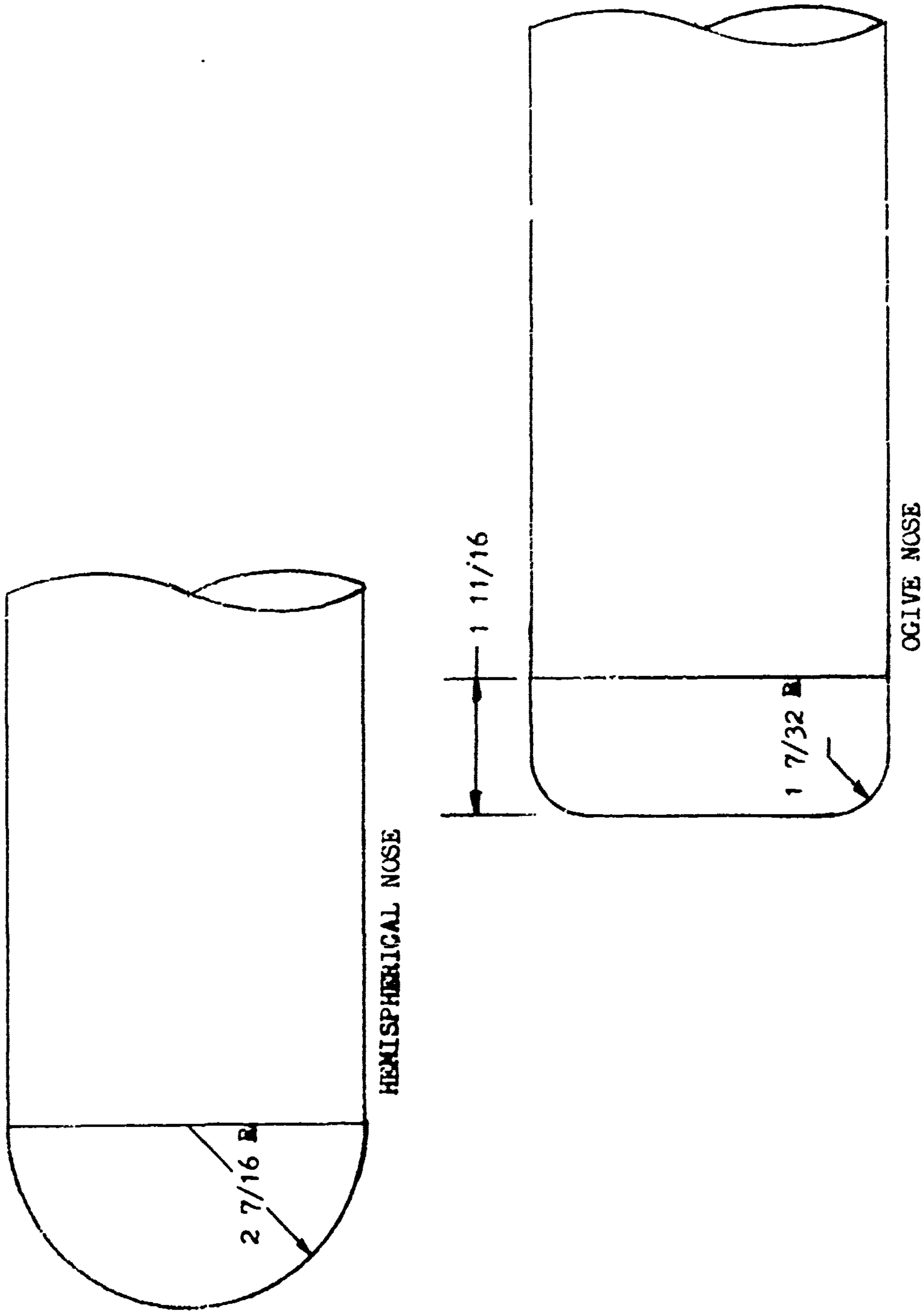

Figure 6: BODY NOSE SHAPES

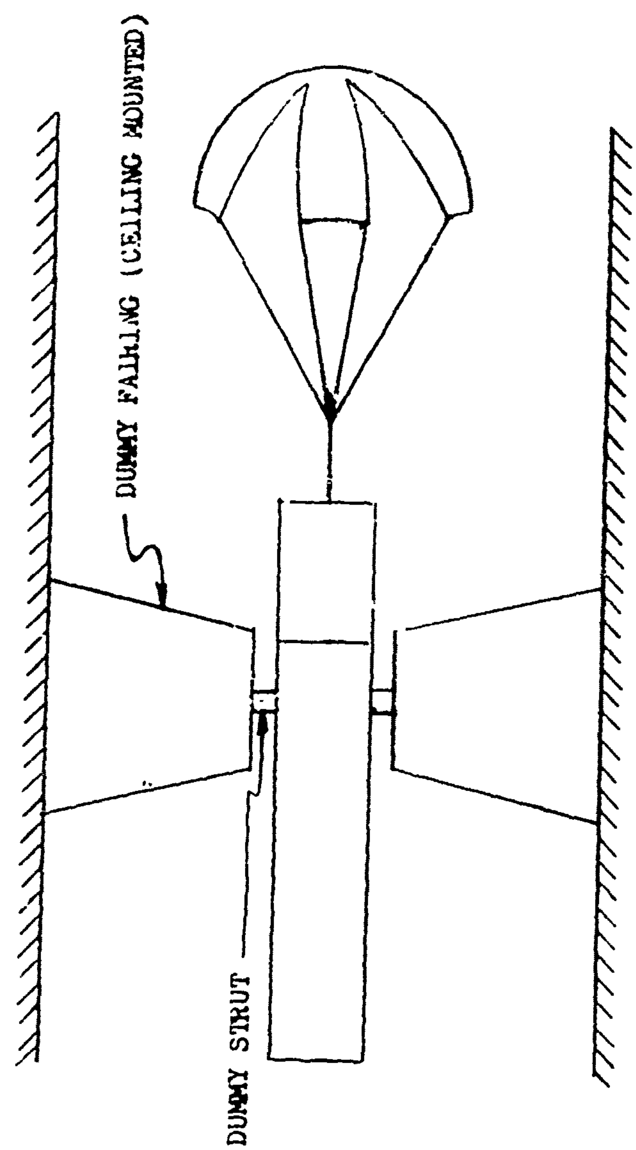

Figure 7: TARE AND INTERFERENCE TEST SET UP

RUN #	DESCRIPTION	V ft/sec	q lb/ft^2	D lb	D* lb	T/I lb	D_o lb	C_DS ft^2	$\overline{C_DS}$ ft^2
1 35 T/I	CROWN FLOCELERATOR with 36 in. Square Parachute (0.8 oz nylon) Flocelerator Bag Mat'l Wt: 7 oz	60 100 200 300	4.28 11.89 47.56 107.03	14.17 36.92 162.32 370.87	13.83 38.03 153.61	-.34 -.89 -8.82	14.51 39.81 171.14	3.39 3.35 3.60	3.45
2 35 T/I	CROWN FLOCELERATOR with 36 in. Square Parachute (0.8 oz nylon) Flocelerator Bag Mat'l Wt: 5.4 oz	60 100 200	4.28 11.89 47.56	15.39 41.61 164.57	13.83 38.03 153.61	-1.56 -3.58 -11.26	16.95 45.19 175.83	3.96 3.80 3.70	3.82
3 35 T/I	CROWN FLOCELERATOR with 12 x 42 Cross Parachute (1.1 oz ripstop) Flocelerator Bag Mat'l Wt: 7 oz	60 100 200	4.28 11.89 47.56	18.26 46.45 188.02	13.83 38.03 153.61	-4.43 -8.42 -34.41	22.69 54.87 222.43	5.30 4.61 4.68	4.86
4 35 T/I	CROWN FLOCELERATOR with 12 x 42 Cross Parachute (1.1 oz ripstop) Flocelerator Bag Mat'l Wt: 5.4 oz	60 100 200	4.28 11.89 47.56	14.02 N/A N/A	13.83 38.03 153.61	-.19	14.21	3.32	N/A
5 36 T/I	MODIFIED TORPEDO BAG with 36 in. Square Parachute (0.8 oz nylon)	60 100 200 300	4.28 11.89 47.56 107.03	15.10 41.73 165.74 374.26	14.02 38.47 160.37	-1.08 -3.26 -5.10	16.18 44.99 170.84	3.78 3.78 3.59	3.72
6 36 T/I	MODIFIED TORPEDO BAG with 36 in. Square Parachute (0.8 oz nylon) and with Variable Inlet Length	60 100 200	4.28 11.89 47.56	15.81 40.45 160.01	14.02 38.47 160.37	-1.79 -1.98 + .36	17.60 42.43 159.65	4.11 3.57 3.36	3.68
6-5 36 T/I	MODIFIED TORPEDO BAG with 36 in. Square Parachute (0.8 oz nylon) and with Inlet shortened by 2 in.	60 100 200	4.28 11.89 47.56	15.73 41.84 164.29	14.02 38.47 160.37	-1.71 -3.37 -3.92	17.44 45.21 168.21	4.07 3.80 3.54	3.80

Figure 8: DATA REDUCTION (Sheet 1 of 5)

RUN #	DESCRIPTION	V ft/sec	q lb/ft	D lb	D* lb	T/I lb	D_o lb	$C_D S$ ft^2	$\overline{C_D S}$ ft^2
7	MODIFIED TORPEDO BAG with 12 x 42	60	4.28	19.59	14.02	-5.57	25.16	5.88	
	Cross Parachute (1.1 oz ripstop)	100	11.89	50.00	38.47	-11.5	61.50	5.17	5.18
36 T/I		200	47.56	187.16	160.37	-26.8	213.96	4.50	
8	Re-test of CROWN FLOCELERATOR with 12 x 42 Cross Parachute (1.1 oz ripstop) Flocelerator Bag Mat'l Wt: 5.4 oz	No data taken--model failed at the suspension lines on deployment at 200 ft/sec							
9	7.5 in Diameter Flat Circular	100	11.89	4.28	6.18	+1.9	2.38	0.20	
	Ribbon Parachute (Crane)	200	47.56	16.31	24.48	8.17	6.14	0.17	0.19
32 T/I		300	107.03	36.72	(2.25 @ 60 fps)				
10	10.5 in Diameter Flat Circular	60	4.28	2.36	2.25	-.11	2.47	0.57	
	Ribbon Parachute (Steinthal)	100	11.89	5.88	6.18	.30	5.58	0.47	0.49
32 T/I		200	47.56	22.29	24.48	1.69	20.60	0.43	
		300	107.03	51.46					
11	9.5 in Diameter Flat Circular	60	4.28	2.35	2.25	-.1	2.45	0.57	
	Ribbon Parachute (Crane)	100	11.89	5.72	6.18	.46	5.26	0.44	0.47
32 T/I		200	47.56	21.84	24.48	2.64	19.20	0.40	
		300	107.03	52.01					
12	13 in Diameter Flat Circular	60	4.28	3.05	2.25	-.8	3.85	0.90	
	Ribbon Parachute (Crane)	100	11.89	8.38	6.18	-2.2	10.58	0.89	0.89
32 T/I		200	47.56	33.06	24.48	-8.6	41.66	0.88	
		300	107.03	71.83					

Figure 8: DATA REDUCTION (Sheet 2 of 5)

RUN #	DESCRIPTION	V ft/sec	q lb/ft^2	D lb	D* lb	T/I lb	D_o lb	C_DS ft^2	$\overline{C_DS}$ ft^2
13	13.5 in Diameter Flat Circular	60	4.28	3.05	2.25	-.8	3.85	0.90	
	Ribbon Parachute (Pioneer)	100	11.89	6.47	6.18	-.3	6.77	0.57	0.74
32 T/I		200	47.56	30.27	24.48	-5.8	36.07	0.76	
		300	107.03	58.79					
14	14 in Diameter Flat Circular	60	4.28	3.06	2.25	-.8	3.86	0.90	
	Ribbon Parachute (Crane)	100	11.89	7.24	6.18	-1.06	8.30	0.70	0.75
32 T/I		200	47.56	27.7	24.5	-3.22	30.92	0.65	
		300	107.03	59.9					
15	15 in Diameter Flat Circular	60	4.28	3.6	2.25	-1.33	4.93	1.15	
	Ribbon Parachute (Crane)	100	11.89	9.86	6.18	-3.68	13.54	1.14	1.13
32 T/I		200	47.56	38.45	24.48	-13.97	52.42	1.10	
		300	107.03	76.2					
16	10 x 30 Double Crown Cross	60	4.28	11.11	9.84	-1.27	12.38	2.89	
	Parachute (Steinthal)	100	11.89	28.48	27.0	-1.8	30.28	2.55	2.60
33 T/I		200	47.56	111.5	111.2	-.28	111.78	2.35	
		300	107.03	242.15					
17	12 x 42 Double Crown Cross	60	4.28	21.7	15.8	-5.9	27.6	6.45	
	Parachute (Crane)	100	11.89	53.6	41.4	-12.5	66.1	5.56	6.01
34 T/I		200	47.56	NA	163.4				
		300	107.03	377.[illegible]					
18	12 x 42 Single Crown Cross	60	4.28	15.8	15.8	0	15.8	3.69	
	Parachute (Steinthal)	100	11.89	41.9	41.1	-.8	42.7	3.59	3.64
34 T/I		200	47.56	168.2	163.4	-4.8	173.0	3.64	
		300	107.03	376.7					

Figure 8: DATA REDUCTION (Sheet 3 of 5)

RUN #	DESCRIPTION	V ft/sec	q lb/ft^2	D lb	D* lb	T/I lb	D_o lb	C_DS ft^2	$\overline{C_DS}$ ft^2
19 34 T/I	12 x 42 Single Crown Cross Parachute (Crane)	No data taken -- parachute continued to wind up							
22 34 T/I	12 x 42 Single Crown Cross Parachute (Crane)	No data taken -- parachute continued to wind up							
23	12 x 42 Single Crown Cross Parachute (Steinthal)	50	2.97	10.66	10.59	-.07	10.73	3.61	3.53
		75	6.68	23.21	23.00	-.21	23.42	3.51	
34 T/I		100	11.89	41.39	41.14	-.25	41.64	3.50	
		200	47.56	164.45	163.45	-1.00	165.45	3.48	
24	12 x 42 Single Crown Cross Parachute (Crane)	50	2.97	12.87	10.59	-2.28	15.15	5.10	4.76
		75	6.68	26.22	23.00	-3.22	29.44	4.41	
34 T/I		100	11.89	Parachute started to wind at this point					
		200	47.56						
25	12 x 42 Double Crown Cross Parachute (Crane)	50	2.97	13.65	10.59	-3.06	16.71	5.63	4.89
		75	6.68	25.35	23.00	-2.35	27.70	4.15	
34 T/I		100	11.89	Parachute started to wind at this point					
		200	47.56						
26	Basic Cylindrical A-size Body 4 7/8 Diameter x 36 in. Long	50	2.97	.57	.73	.16	.41	0.14	.15
		60	4.28	.84	.92	.08	.76	0.18	
31 T/I		75	6.68	1.19	1.44	.25	.94	0.14	
		100	11.89	2.13	2.48	.35	1.78	0.15	
		200	47.56	8.05	9.95	1.90	6.15	0.13	
		300	107.03	18.37					

Figure 8: DATA REDUCTION (Sheet 4 of 5)

RUN #	DESCRIPTION	V ft/sec	q lb/ft^2	D lb	D* lb	T/I lb	D_d lb	C_DS ft^2	$\overline{C_DS}$ ft^2
27	A-size Sonobuoy Body equipped	50	2.97	.26	.43	.17	.09	.03	
	with OGIVE nose	75	6.68	.53	.80	.20	.33	.05	
30 T/I		100	11.89	.91	1.51	.60	.31	.03	.038
		200	47.56	4.01	6.29	2.28	1.73	.04	
		300	107.03	9.19					
28	A-size Sonobuoy Body equipped	50	2.97	.27	.36	.09	.18	.06	
	with HEMISPHERICAL nose	75	6.68	.51	.86	.35	.16	.02	
29 T/I		100	11.89	1.06	1.42	.36	.70	.06	.045
		200	47.56	4.03	6.21	2.15	1.88	.04	
		300	107.03	9.02					
20	Conventional Rotochute on A-size	50	2.97	11.64		.16	11.48	3.86	
	Sonobuoy Body	75	6.68	25.99		.25	25.74	3.85	
no T/I		100	11.89	45.60		.35	45.25	3.81	3.87
		200	47.56	189.44		1.90	187.54	3.94	
		300	107.03	Model failed at this point.					

Figure 8: DATA REDUCTION (Sheet 5 of 5)

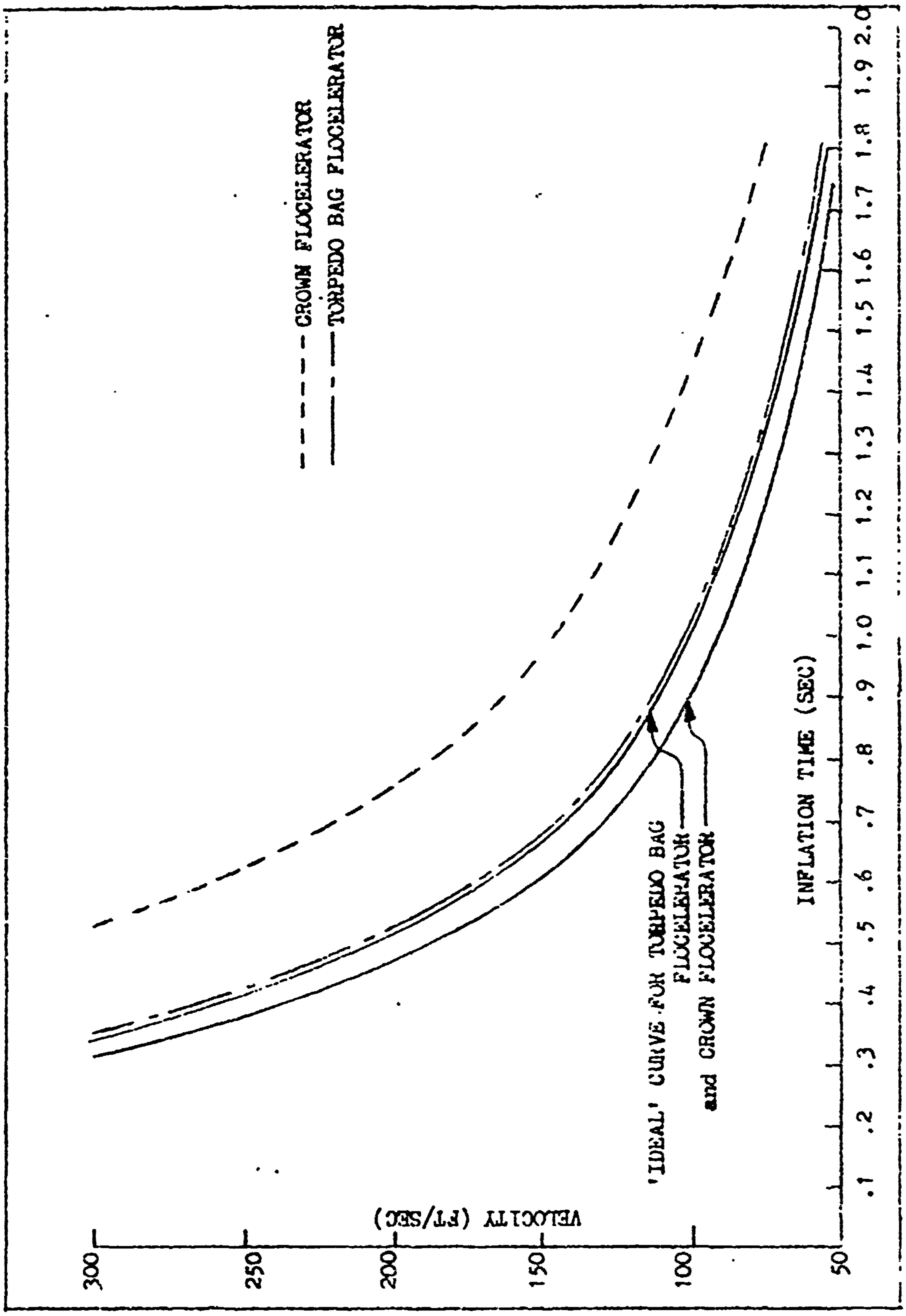

Figure 9: FLOCELERATOR INFLATION TIME CURVE

RUN #	MODEL	$\overline{C_D}S$ ft^2	S ft^2	$\overline{C_D}$	COMMENTS
1-2	CROWN FLOCELERATOR with 36 in. Square Parachute (0.8 oz nylon)	3.49	9	.39	Run #2 -- Model failed at parachute/bag attachment when deployed at approximately 300 ft/sec
3-4 & 8	CROWN FLOCELERATOR with 12 x 42 Cross Parachute	4.71	6	.79	Run #3 & 4 -- Constant wrap up caused by turning parachute
5—6-5	MODIFIED TORPEDO BAG with 36 in. Square Parachute	3.61	9	.40	Run #6-5 -- Inlet cut down 2 inches No significant change in drag data.
7	MODIFIED TORPEDO BAG with 12 x 42 Cross Parachute	5.03	6	.84	Model 'throbs' -- tendency for cross parachute to turn transmitted by taut suspension lines
9	7.5 in Diameter Flat Circular Ribbon Parachute (Crane)	.04	.31	.13	7.5 in. Diameter parachute made by NADC by cutting down a 10 in parachute
10	10.5 in Diameter Flat Circular Ribbon Parachute (Steinthal)	.34	.60	.57	28 inch riser length
11	9.5 in Diameter Flat Circular Ribbon Parachute (Crane)	.32	.49	.65	18 inch riser length
12	13 in Diameter Flat Circular Ribbon Parachute (Crane)	.74	.92	.80	18 inch riser length
13	13.5 in Diameter Flat Circular Ribbon Parachute (Pioneer)	.59	.99	.60	Bottom ribbon not taut -- parachute not inflating properly
14	14 in Diameter Flat Circular Ribbon Parachute (Crane)	.60	1.07	.56	Bottom ribbon not taut -- parachute not inflating properly

Figure 10: TEST RESULTS (Sheet 1 of 2)

RUN #	MODEL	$\overline{C_D S}$ ft^2	S ft^2	$\overline{C_D}$	COMMENTS
15	15 in Diameter Flat Circular Ribbon Parachute (Crane)	.98	1.23	.79	Bottom ribbon not taut — parachute not inflating properly
16	10 x 30 Double Crown Cross Parachute (Steinthal)	2.45	3.47	.71	Stable
17 & 25	12 x 42 Double Crown Cross Parachute (Crane)	5.30	6	.88	Tendency to rotate
18 & 23	12 x 42 Single Crown Cross Parachute (Steinthal)	3.44	5.1	.67	Stable — Area (S) based on actual cloth area, not nominal.
19, 22 & 24	12 x 42 Single Crown Cross Parachute (Crane)	4.61	6	.77	Tendency for parachute to wrap up
26	Basic Cylindrical A-size Body 4 7/8 in Diameter x 36 in Long	.15	.13	1.15	
27	A-size Sonobuoy Body equipped with OGIVE nose	.038	.13	.29	
28	A-size Sonobuoy Body equipped with HEMISPHERICAL nose	.045	.13	.35	Flow disrupted by uneven joint between nose and cylinder
20	Conventional Rotochute on A-size Sonobuoy Body	3.72	3.14	1.18	Model failed at 'washer-type' bearing during test (~300 ft/sec)

Figure 10: TEST RESULTS (Sheet 2 of 2)